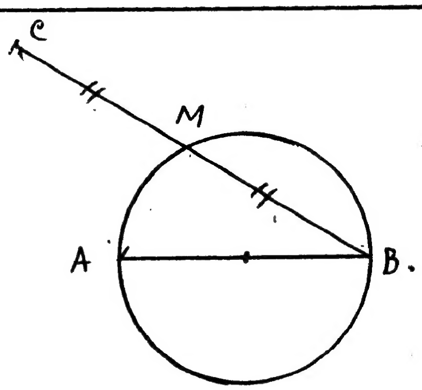
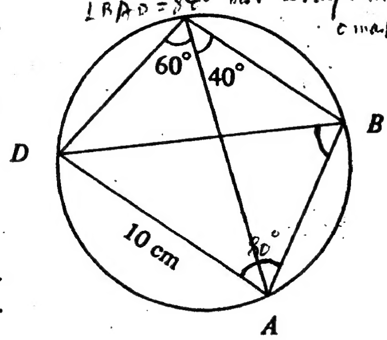
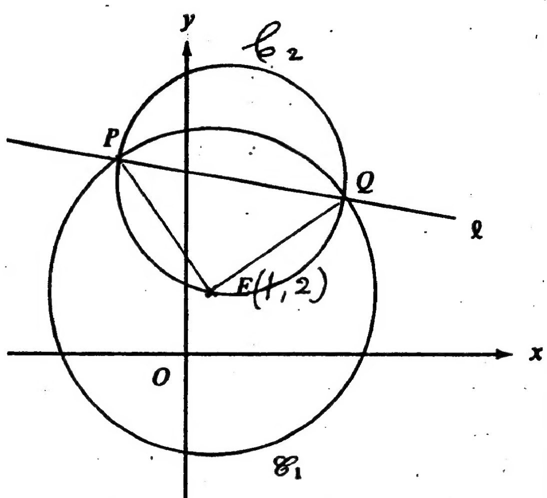
Solution	Marks	Remarks
1. (a) Increase percentage = $\left(\frac{1000}{8000} \times 100\right)\%$	1A	for $\frac{1000}{8000}$
$= 12.5\%$	1A	Accept 12.5
	2	
(b) His savings = $\$9000 \times \frac{3}{10}$	1A	
$= \$2700$	1A	
	2	
2. (a) $x + 1 > \frac{1}{5}(3x + 2)$		OR
		$x - \frac{3}{5}x > \frac{2}{5} - 1$ 1M
$5x - 3x > 2 - 5$	1M	$\frac{2}{5}x > -\frac{3}{5}$
$2x > -3$		$x > -\frac{3}{2}$ 1A
$x > -\frac{3}{2}$	1A	
	2	
(b) Furthermore, if $-4 \leq x \leq 4$, then the range of x is		
$-\frac{3}{2} < x \leq 4$.	2A	-1 if '=' incorrect Accept graphical representation
	2	
3. (a) Since $(x + 1)$ is a factor of $x^4 + x^3 - 8x + k$,		
$(-1)^4 + (-1)^3 - 8(-1) + k = 0$ omitted. PP-1	1M	
$k = -8$	1A	
	2	
(b) $x^4 + x^3 - 8x - 8 = (x + 1)(x^3 - 8)$	1M+1A	1M for $(x+1) \times$ cubic exp.
$= (x + 1)(x - 2)(x^2 + 2x + 4)$	1A+1A	1A for each factor of $x^3-8=(x-2)(x^2+2x+4)$
	4	
OR $(2)^4 + (2)^3 - 8(2) - 8 = 0$		
$\rightarrow$ $x - 2$ is another factor	1A 2A	
$\therefore$ $x^4 + x^3 - 8x - 8 = (x + 1)(x - 2)(x^2 + 2x + 4) = 0$ PP-1	1M+2A 1A	1M for $(x+1)(x-2) \times$ quadratic exp.

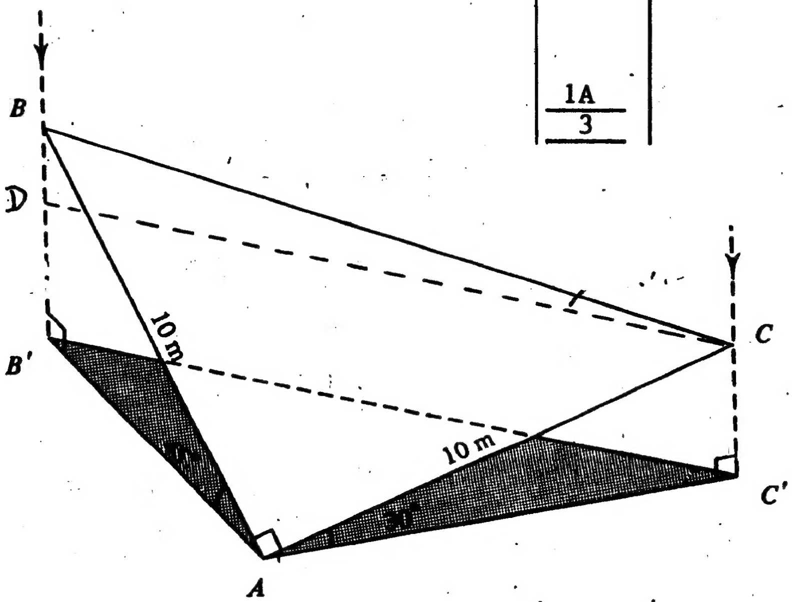
Solution	Marks	Remarks
4. (a) 	1A	For circle with A,B,M
	1A 2	Point C Indication of BM = MC
(b) Consider ΔABM and ΔACM (<u>OR</u> joining AM, AC)	1	In this part, candidates are expected to give brief reasons.
Since AB is a diameter, $\angle AMB = 90°$ $= \angle AMC$ OR ($\angle AMB = \angle AMC$) indicate on the graph o.k.	1	
As AM is common and BM = MC, the two triangles are congruent. (SAS)	1	State $\Delta AMB \cong \Delta AMC$ (with proof).
$\therefore \angle BAM = \angle CAM$, i.e. AM bisects $\angle BAC$.	1 4	conclude AM bisects $\angle BAC$. state $\Delta AMB \cong \Delta AMC$ (with reason) 2 marks conclude AM bisect $\angle BAC$ (3 marks)
5. (a) $\begin{cases} x + 2y = 5 & \text{..........(i)} \\ 5x - 4y = 4 & \text{..........(ii)} \end{cases}$		
$2 \times (i) + (ii) \Rightarrow 7x = 14$	1M	For elim. or subs.
$x = 2$	1A	
Putting $x = 2$ in (i), $2y = 3$		
$y = \frac{3}{2}$	1A	
$\therefore$ the solution is $\begin{cases} x = 2 \\ y = \frac{3}{2} \end{cases}$	3	
(b) By (a), $\frac{a}{c} = 2$ and $\frac{b}{c} = \frac{3}{2}$	~~1M~~ 2M	
$a : b : c = 4 : 3 : 2$ (or equivalent ratios)	~~2A~~ 1A 3	
6. (a) $\angle ABD$ (= $\angle ACD$) = 60°	1A	
Since ABCD is a cyclic quadrilateral,		angle shown in diagram o.k.
$\angle BAD + \angle BCD = 180°$ $\therefore \angle BAD = 180° - (60 + 40)°$	correct step 1	<u>OR</u> $\angle BDA = 40°$
$= 80°$	1A 3	only $\angle BAD = 80°$ no reason / $\angle BAD = 80°$ but wrong reason 1 mark
(b) By the sine rule,		
$\frac{10}{\sin 60°} = \frac{BD}{\sin 80°}$	1M+1A	
$BD = \frac{10\sin 80°}{\sin 60°}$		
$= 11.37$ cm (corr. to 2 d.p.)	1A 3	

Solution	Marks	Remarks
7. $3\tan\theta = 2\cos\theta$	1M	
$3\dfrac{\sin\theta}{\cos\theta} = 2\cos\theta$		
$3\sin\theta = 2\cos^2\theta$	1M	
$3\sin\theta = 2(1 - \sin^2\theta)$	1A	
$\therefore\ 2\sin^2\theta + 3\sin\theta - 2 = 0$	1A	
$(2\sin\theta - 1)(\sin\theta + 2) = 0$	1A	Accept '$\sin\theta = \frac{1}{2}$' or '$\sin\theta = \frac{1}{2}$ or -2'
$\sin\theta = \dfrac{1}{2}$ or -2 (rejected)		
The solutions are $\theta = 30°$ or $150°$ ($\frac{\pi}{6}$ or $\frac{5\pi}{6}$) [as $\cos 30°$ and $\cos 150° \neq 0$].	1A+1A	Deduct 1 for each extraneous solution.
	7	

Solution	Marks	Remarks
8. (a) $E = (1, 2)$	1A	$E = 1, 2$ pp-1
	1	
(b) From $x + 7y - 40 = 0$, we have $x = 40 - 7y$		
(or $y = \frac{40 - x}{7}$)		
Putting in $\mathscr{C}_1$, $(40-7y)^2 + y^2 - 2(40-7y) - 4y - 20 = 0$	1M	
$50y^2 - 550y + 1500 = 0$	1A	
$y^2 - 11y + 30 = 0$ (or $x^2 - 3x - 10 = 0$)		
$(y - 5)(y - 6) = 0$		
$y = 5$ or 6 (or $x = 5$ or -2)	1A	$y=5$ and $y=6$ pp-1
$x = 5$ or -2		
$\therefore P = (-2, 6)$, $Q = (5, 5)$	1A	Accept $P = (5, 5)$ $Q = (-2, 6)$
	4	
(c) $\mathscr{C}_2$ is given by $\frac{y - 6}{x + 2} \cdot \frac{y - 5}{x - 5} = -1$	1M+1A	OR Ctr. of $\mathscr{C}_2 = (\frac{3}{2}, \frac{11}{2})$ radius $= \frac{5\sqrt{2}}{2}$ $(=3.54)$ } 1A
i.e. $x^2 + y^2 - 3x - 11y + 20 = 0$	1A	Eqt. of $\mathscr{C}_2$: $(x-\frac{3}{2})^2 + (y-\frac{11}{2})^2 = \frac{50}{4}$ } 1M+1A Answer
	3	
(d) Putting $(x, y) = (1, 2)$ in L.H.S. of $\mathscr{C}_2$	1M	OR Slope of PE x slope of QE = -1
$1^2 + 2^2 - 3(1) - 11(2) + 20 = 0$	1A	
$\therefore \mathscr{C}_2$ passes through E		
(As PQ is a diameter of $\mathscr{C}_2$,) $\angle PEQ = 90°$	1M)	OR Let $P = (-2,6)$, $Q = (5,5)$
(Since PE = QE (radii of $\mathscr{C}_1$),)	)	Slope of PQ $= -\frac{1}{7}$
$\angle EPQ = \frac{90°}{2} = 45°$	1A)	Slope of PE $= -\frac{4}{3}$
		$\tan \angle EPQ = \dfrac{-\frac{1}{7} - \frac{-4}{3}}{1 + \frac{1}{7} \times \frac{4}{3}}$ 1M $= 1$ $\angle EPQ = 45°$ 1A OR $171.87° - 126.87°$ 1M $= 45°$ 1A
	4	

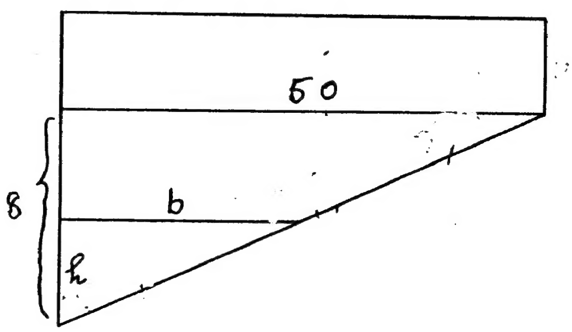
Solution	Marks	Remarks
9. (a) $\frac{k}{1} = \frac{\frac{1}{2}}{k}$	1M	
$k^2 = \frac{1}{2}$		
$k = \frac{1}{\sqrt{2}}$ (or $\frac{\sqrt{2}}{2}$)(as $k > 0$)	1A	Do not accept $\pm \frac{1}{\sqrt{2}}$ but follow through
	2	
(b) $T(n) = (\frac{1}{\sqrt{2}})^{n-1}$ [or $\frac{1}{(\sqrt{2})^{n-1}}$, $2^{-\frac{n-1}{2}}$, etc.]	1M+1A	$\frac{1}{\sqrt{2}}^{n-1}$ p.p.
	2	
(c) Sum to infinity $= \frac{1}{1 - \frac{1}{\sqrt{2}}}$	1M+1A	
$= \frac{\sqrt{2}}{\sqrt{2} - 1}$		
$= \frac{\sqrt{2}(\sqrt{2} + 1)}{(\sqrt{2} - 1)(\sqrt{2} + 1)}$	1M	
$= 2 + \sqrt{2}$	1A	
	4	
(d) No. of terms in the product $= \frac{2n - 1 - 1}{2} + 1 = n$		
$T(1) \times T(3) \times T(5) \times \ldots \times T(2n-1)$		
$= 1 \times \frac{1}{2} \times \frac{1}{4} \ldots \times (\frac{1}{\sqrt{2}})^{2n-2}$	1A	
[or $1 \times \frac{1}{(\sqrt{2})^2} \times \frac{1}{(\sqrt{2})^4} \times \ldots \times \frac{1}{(\sqrt{2})^{2n-2}}$]		
$= 1 \times \frac{1}{2} \times \frac{1}{2^2} \times \ldots \times \frac{1}{2^{n-1}}$		
$= \frac{1}{2^{1+2+\ldots+(n-1)}}$	1M	
$= \frac{1}{2^{\frac{n(n-1)}{2}}}$ [or $2^{\frac{-n(n-1)}{2}}$, etc.]	1M+1A	1M for summing index as A.P.
	4	

Solution	Marks	Remarks
10. (a) $AB' = 10\cos 45°$		
$= 5\sqrt{2}\text{m}$ (or $\frac{10}{\sqrt{2}}$), (7.07107)	1A	Any figure roundable to 7.07
$AC' = 10\cos 30°$		
$= 5\sqrt{3}\text{m}$ (8.66025)	1A	
	2	
(b) $BC = \sqrt{10^2 + 10^2}$		
$= 10\sqrt{2}\text{m}$ (14.14214)	1A	No unit, -1 m. for whole paper
$BB' = 10\sin 45°$		u − 1
$= 5\sqrt{2}\text{m}$ (7.07107)	1A	
$CC' = 10\sin 30°$		
$= 5\text{m}$	1A	
	3	



Solution	Marks	Remarks
(c) Let D be the foot of the perpendicular from C to BB'.		
$BD = (5\sqrt{2} - 5)\text{m}$ (=2.07107)	1M	
$B'C' = CD$		
$= \sqrt{(10\sqrt{2})^2 - (5\sqrt{2} - 5)^2}$	1M	
$= \sqrt{125 + 50\sqrt{2}}\text{m}$ (= 13.9897)	1A	Accept figures roundable to 13.9 – 14.0
	3	
(d) By the cosine rule,		
$\cos B'AC' = \dfrac{50 + 75 - (125 + 50\sqrt{2})}{2 \times 5\sqrt{2} \times 5\sqrt{3}}$ (= $-\frac{1}{\sqrt{3}}$, −0.57735)	1M	
$\angle B'AC' = 125°$ (125.264)	1A	124° – 125°
Area of the shadow $= \frac{1}{2} \times 5\sqrt{2} \times 5\sqrt{3}\sin 125.264°$	1M	For $\Delta = \frac{1}{2}ab\sin C$
$= 25\text{m}^2$	1A	25.0 – 25.4
	4	

Solution	Marks	Remarks
11. (a) Area of cross-section $= \frac{50}{2}(2+10) = 300\text{m}^2$		
Vol. of water $= 20 \times 300 = 6000\text{m}^3$	2cA 1M+1A	1M for Vol.= Area of cross-section x width
		OR $\boxed{20\times 50\times 2}$ + $\frac{1}{2}(50\times 5)\times 20$ 2000
	2	
(b) (i) When the depth of water at the deeper end is 8m, the cross-section of water is a triangle of area $\frac{8 \times 50}{2} = 200\text{m}^2$.		OR Drop in water level = 2m Water pumped out $= 2\times50\times20 = 2000\text{m}^3$ 1A
Vol. of water left $= 200 \times 20 = 4000\text{m}^3$.	2A	Water left $= 4000\text{m}^3$ 1A
(ii) Vol. of water pumped out in 8 hours		
$= (0.125)^2\pi \times 3600 \times 8 \times 3$	1M+1A	1M for area of cross-section
$= 1350\pi\ \text{m}^3$		
$= 4241\text{m}^3$ (correct to the nearest m^3) (4241.15)	1A	
(iii) Vol. of water left after 8 hrs $= 6000 - 4241$	1M	
$= 1759\text{m}^3$		
When the depths of water are 8m and h m, the corresponding cross-sections of water are two similar triangles with bases 50m and b m.		
$\frac{b}{h} = \frac{50}{8}$ or $b = \frac{50}{8}h$	1A	
$\therefore \frac{1}{2}b \times h \times 20 = 1759$	1M	$\left(\frac{h}{8}\right)^2 = \frac{1759}{4000}$
$\frac{20}{2} \times \frac{50}{8}h^2 = 1759$	1M	
$h = 5.305 = 5.3$ (correct to 1 d.p.)	1A	
	10	



Solution	Marks	Remarks
12. (a) (i) Area of $\triangle OAB = \frac{1}{2}(2)(2)\sin\theta = 2\sin\theta$ $\underline{cm^2}$ u-1	1A	
(ii) The area is greatest when $\theta = \frac{\pi}{2} \approx 1.57$	1A	90° not acceptable
	2	
(b) Area of sector OAB $= \frac{1}{2}(2)^2\theta = 2\theta$ (cm^2) ↑optional.	1A	
$2\theta - 2\sin\theta = 2$	1M	
$\therefore \theta - \sin\theta - 1 = 0$	1A	
	3	
(c) $f(0) = 0 - 0 - 1 < 0$; $f(3) = 3 - \sin 3 - 1$ $(=1.859) > 0$ ↑If wrong, 1A is not given.	1M	For sub. f(0), f(3) Accept graphical method
$\therefore 0 < \alpha < 3$, If omitted, no 1A	1A	
	2	
(d) see table below		

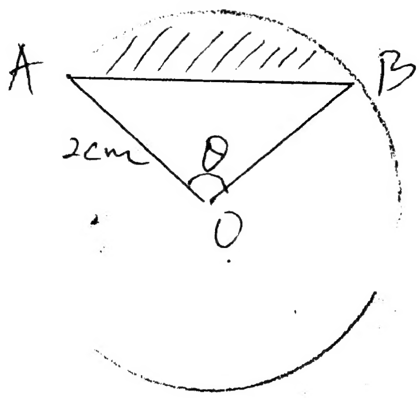
Interval	Mid-value θ	f(θ)
$0 < \alpha < 3$	1.5	−
$1.5 < \alpha < 3$	2.25	+
$1.5 < \alpha < 2.25$	1.875 (1.88)	−
$1.875 < \alpha < 2.25$	2.063 (2.06)	+
$1.875 < \alpha < 2.063$	1.969 (1.97)	+
$1.875 < \alpha < 1.969$	1.922 (1.92)	−
$1.922 < \alpha < 1.969$	1.946 (1.95)	+
$1.922 < \alpha < 1.946$		

Marks for (d): 1M+1A (row $0 < \alpha < 3$) — 1M Testing of sign at mid-value of suitable interval; 1A Correct sign. 1M (row $1.5 < \alpha < 3$) — Correct choice of sub-interval. 1A (row $1.922 < \alpha < 1.969$).

We see that α lies between 1.922 and 1.946.

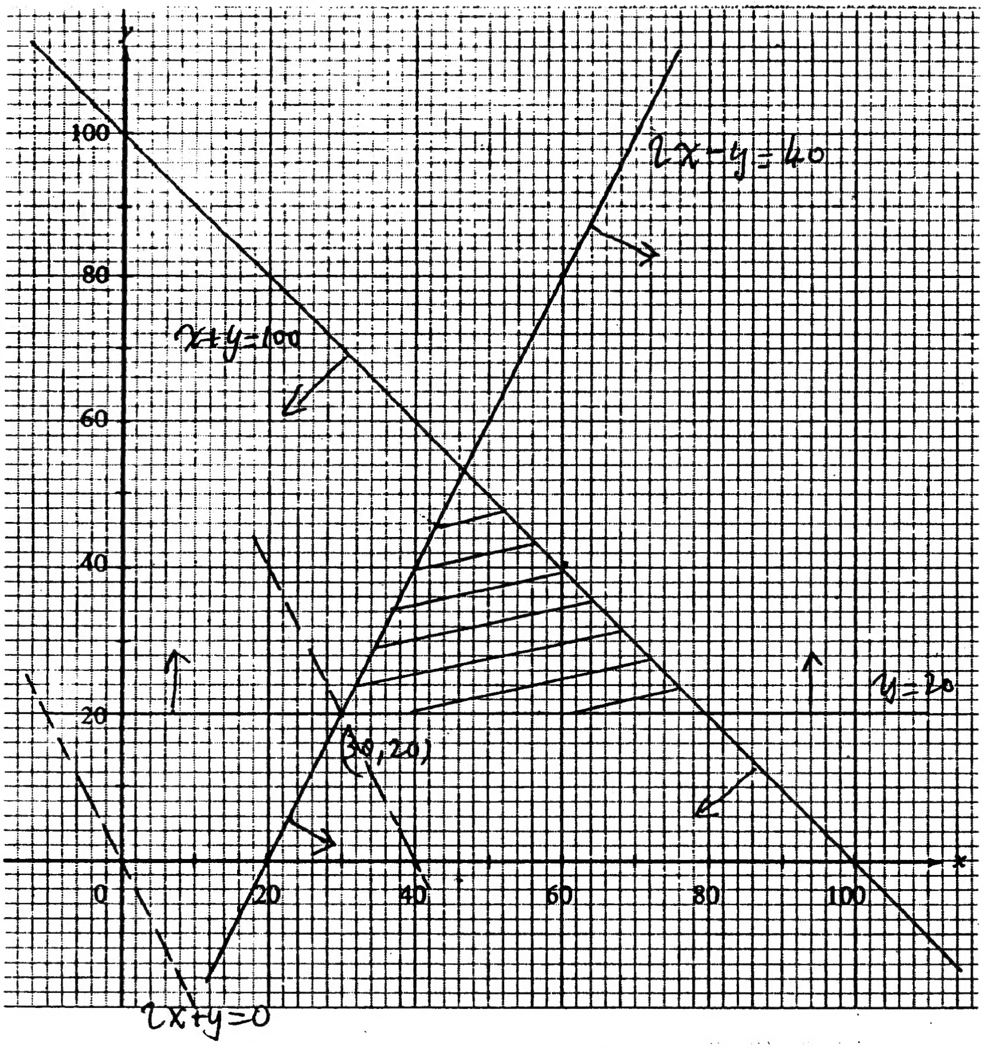
$\therefore \alpha = 1.9$ (correct to 1 d.p.) 1A

Total: 5



Solution	Marks	Remarks
13. (a) Since $p + q = 1$,	1A	optional
putting $p = 3q$		only $q = \frac{1}{4}$ 1A.
$4q = 1$		
$q = \frac{1}{4}$	1A 2	
(b) (i) The probability that the first ball drawn is black is $\frac{n}{10}$.	1A	
After a black ball has been drawn, the probability of drawing a second black ball is $\frac{n-1}{9}$.	1A	
$\therefore$ the probability that both balls are black		
$= \frac{n}{10} \times \frac{n-1}{9}$	1M	$\frac{n}{10} \times \frac{n-1}{9}$ 1A+1A+1M
$= \frac{n(n-1)}{90}$		$\frac{n}{10} \times \frac{n-1}{10}$ wrong 1A+1M
(ii) $\frac{n(n-1)}{90} > \frac{1}{3}$	1M	
$3n^2 - 3n - 90 > 0$	1A	
$n^2 - n - 30 > 0$		
$(n-6)(n+5) > 0$		
$\therefore$ $n > 6$ or $n < -5$	1A	Accept $n > 6$ without $n < -5$
As n is integral and positive, n = 7, 8, 9 or 10.	1A 7	by testing $n = 7, 8, 9, 10$ 3A all correct
(c) The probability that the first ball drawn is red and the second is also red $= \frac{1}{2} \times \frac{4}{6}$ $(= \frac{1}{3})$.	1A	
The probability that the first is green and the second is red $= \frac{1}{2} \times \frac{3}{6}$ $(= \frac{1}{4})$.	1A	
$\therefore$ the probability that the ball drawn from N is red $= \frac{1}{3} + \frac{1}{4} = \frac{7}{12}$.	1A 3	

no explaining pp-1
only expression

Solution	Marks	Remarks
14. (a). 	1A + 1A + 1A	1A for each line ±1 horizontal/ vertical unit at (100, 0),(0, 100); (20, 0),(60, 80); (0, 20),(100, 20)
	1A	Region
	4	
(b) (i) $z = 100 - x - y$	1A	
(ii) Cost of mixture $= 6x + 5y + 4z$	1A	
$= 6x + 5y + 4(100 - x - y)$		
$= 2x + y + 400$ dollars	1A	
(iii) $400x + 600y + 400z \geq 44\ 000$	1A	
$800x + 200y + 400z \geq 48\ 000$	1A	
Putting $z = 100 - x - y$, $y \geq 20$		
$2x - y \geq 40$		
Further, (as $z \geq 0$, $100 - x - y \geq 0$) $x + y \leq 100$	1A	
(iv) Drawing the line $2x + y = 0$ in the figure,	1M	Any line.
the least cost is attained when $x = 30$, $y = 20$.		Costs at (30,20), (80,20),$(\frac{140}{3}, \frac{160}{3})$
$\therefore$ $x = 30$, $y = 20$, $z = 50$	1A	are 480, 580 and 546.7 (Any point)
	8	